

## STRUCTURAL CALCULATIONS Fire Station 2 Solar Panel Addition

Madison, WI


PREPARED FOR:
City of Madison
DCE JOB \#:
21COMDO4

## DC ENGINEERING

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## ROOF ANALYSIS

$\qquad$ of $\qquad$

# DC ENGINEERING 

Careful listening. Dynamic solutions.
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CHECKED BY $\qquad$ dATE $\qquad$

## Project Summary

Adding (2) solar arrays to roof of existing structure. Mounting equipment does not require direct attachment to deck and is secured using ballast blocks. Additional load to deck and framing is 4 PSF.

Fire Station 2 Existing Roof Analysis
Original Design Loads

## Snow load

Ground snow load = 30 PSF
Roof snow load = 30 PSF per original plans
Drift at each array:
Height of each array = 1.1', no additional drift at each array
Dead load
3" Tectum + 1-1/4" urethane $=5.5$ PSF + 1 PSF = 6.5 PSF
EPDM membrane + roof ballast $=5.5 \mathrm{PSF}$
MEP = 1.5 PSF
DL = 13.5 PSF

Compare applied loads to allowable loads using H -series joist tables.
Array 1 and 2:
28H9 joist @ 5' O.C.
Span = 49'
Max. allowable loads from H-series table
Total load = 278 PLF
Live load (for L/360 deflection) = 144 PLF
No ceiling attached to H-joists, can use live load for L/240 deflection: (144 PLF)(1.5) = 216 PLF

Max. applied loads
DL = 15.2 PLF + (17.5 PSF)(5 FT) = 102.7 PLF
LL = (30 PSF)(5 FT) = 150 PLF

Total load = 150 PLF + 102.7 PLF = 252.7 PLF < 278 PLF OK
Live load = 150 PLF < 216 PLF OK
28 H 10 and 28 H 11 acceptable by inspection.
W16x31 Beams:
Longest span = 19.5'
Roof tributary $=3.6^{\prime}$
Beams acceptable as shown.

Project Title:
Engineer:
Project ID:
Project Descr:

Steel Beam
File: Fire_Station2_Existing_Beams.ec6
Lic. \# : KW-06015046
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DC ENGINEERING
DESCRIPTION: EXISTING W16x31

## CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

## Material Properties

| Analysis Method: Allowable Strength Design | Fy: Steel Yield : | 36.0 ksi |
| :--- | :--- | ---: |
| Beam Bracing: | Beam is Fully Braced against lateral-torsional buckling | E: Modulus : |
| Bending Axis: | Major Axis Bending |  |

$D(0.063) \operatorname{Lr}(0.072) S(0.108)$

W16x31
Span $=19.50 \mathrm{ft}$

## Applied Loads

Service loads entered. Load Factors will be applied for calculations.
Beam self weight calculated and added to loading Uniform Load : $\mathrm{D}=0.01750, \mathrm{Lr}=0.020, \mathrm{~S}=0.030 \mathrm{ksf}$, Tributary Width $=3.60 \mathrm{ft},(\mathrm{ROOF}+$ ARRAYS)

| DESIGN SUMMARY |  |  | Design OK |
| :---: | :---: | :---: | :---: |
| Maximum Bending Stress Ratio = | 0.099 : 1 | Maximum Shear Stress Ratio = | 0.031 : 1 |
| Section used for this span | W16x31 | Section used for this span | W16x31 |
| Ma : Applied | 9.601 k-ft | Va : Applied | 1.970 k |
| Mn / Omega : Allowable | $97.006 \mathrm{k}-\mathrm{ft}$ | Vn/Omega : Allowable | 62.964 k |
| Load Combination | +D+S | Load Combination | +D+S |
| Location of maximum on span | 9.750 ft | Location of maximum on span | 0.000 ft |
| Span \# where maximum occurs | Span \# 1 | Span \# where maximum occurs | Span \# 1 |
| Maximum Deflection |  |  |  |
| Max Downward Transient Deflection | 0.032 in | = 7,209 > =360 |  |
| Max Upward Transient Deflection | 0.000 in | $=0<360$ |  |
| Max Downward Total Deflection | 0.061 in R | $0=3855>=240$. |  |
| Max Upward Total Deflection | 0.000 in | $=0<240.0$ |  |

Maximum Forces \& Stresses for Load Combinations

| Load Combination Segment Length | Span \# | Max Stress Ratios |  | Summary of Moment Values |  |  |  |  |  |  | Summary of Shear Values |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | M | V | Mmax + | Mmax - | Ma Max | Mnx | Mnx/Omega | Cb | Rm | Va Max | Vnx | Vnx/Omega |
| D Only |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dsgn. L = 19.50 ft | 1 | 0.046 | 0.015 | 4.47 |  | 4.47 | 162.00 | 97.01 | 1.00 | 1.00 | 0.92 | 94.45 | 62.96 |
| +D+Lr |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dsgn. L = 19.50 ft | 1 | 0.081 | 0.026 | 7.89 |  | 7.89 | 162.00 | 97.01 | 1.00 | 1.00 | 1.62 | 94.45 | 62.96 |
| +D+S |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dsgn. L = 19.50 ft | 1 | 0.099 | 0.031 | 9.60 |  | 9.60 | 162.00 | 97.01 | 1.00 | 1.00 | 1.97 | 94.45 | 62.96 |
| +D+0.750Lr |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dsgn. L = 19.50 ft | 1 | 0.073 | 0.023 | 7.03 |  | 7.03 | 162.00 | 97.01 | 1.00 | 1.00 | 1.44 | 94.45 | 62.96 |
| +D+0.750S |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dsgn. $\mathrm{L}=19.50 \mathrm{ft}$ | 1 | 0.086 | 0.027 | 8.32 |  | 8.32 | 162.00 | 97.01 | 1.00 | 1.00 | 1.71 | 94.45 | 62.96 |
| +0.60D |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dsgn. L = 19.50 ft | 1 | 0.028 | 0.009 | 2.68 |  | 2.68 | 162.00 | 97.01 | 1.00 | 1.00 | 0.55 | 94.45 | 62.96 |

## Overall Maximum Deflections

| Load Combination | Span | Max. "-" Defl | Location in Span | Load Combination | Max. "+" Defl |
| :--- | :---: | ---: | :---: | :---: | :---: |
| $+D+S$ | 1 | 0.0607 | 9.806 | Location in Span |  |
| Vertical Reactions |  |  | 0.0000 |  |  |
| Load Combination | Support 1 | Support 2 |  |  |  |
| Overall MAXimum | 1.970 | 1.970 |  |  |  |
| Overall MINimum | 0.550 | 0.550 |  | Values in KIPS |  |
| D Only | 0.917 | 0.917 |  |  |  |
| $+D+L r$ | 1.619 | 1.619 |  |  |  |
|  |  |  |  |  |  |

Project Title:
Engineer:
Project ID:
Project Descr:


DESCRIPTION: EXISTING W16x31

| Vertical Reactions |  |  | Support notation : Far left is \#1 |
| :--- | ---: | ---: | ---: |
| Load Combination | Support 1 | Support 2 |  |
| $+D+$ S | 1.970 | 1.970 |  |
| $+D+0.750$ Lr | 1.443 | 1.443 |  |
| $+D+0.750 \mathrm{~S}$ | 1.706 | 1.706 |  |
| +0.60 D | 0.550 | 0.550 |  |
| Lr Only | 0.702 | 0.702 |  |
| S Only | 1.053 | 1.053 |  |

## Existing Tectum Roof Deck Analysis:

Maximum applied load = DL + SL = 17.5 PSF + 30 PSF = 47.5 PSF See below for deck capacity

TECTUM ${ }^{\circledR}$ I ROOF DECK DESIGN LOAD DATA

| System | Thickness ${ }^{1}$ | $\begin{aligned} & \text { Wt. } \\ & (\mathrm{PFS})^{1} \end{aligned}$ | 24" | 30" | $36^{\prime \prime}$ | $38^{\prime \prime}$ | 40" | 42" | 44" | 48" | 50" | $52^{\prime \prime}$ | $54^{\prime \prime}$ | 60" | 66" | 72" |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Plank | $2^{*}$ | 3.5 | 130 | 75 | 50 | 45 | 40 | 35 |  |  |  |  |  |  |  |  |
|  | $2-1 / 2^{\prime \prime}$ | 4.5 | 150 | 120 | 80 | 70 | 60 | 50 | 45 | 35 |  |  |  |  |  |  |
|  | 3" | 5.3 | 200 | 125 | 102 | 91 | 82 | 74 | 65 | 50 | 45 | 40 | 35 |  |  |  |
| Long Span Plank | $2^{\prime \prime}$ | 3.8 | 130 | 75 | 75 | 75 | 70 | 64 | 57 | 50 | 45 | 40 | 35 |  |  |  |
|  | 2-1/2" | 4.7 | 150 | 120 | 120 | 120 | 114 | 103 | 93 | 77 | 70 | 65 | 60 | 50 | 35 |  |
|  | $3^{\prime \prime}$ | 5.5 | 200 | 125 | 125 | 125 | 125 | 120 | 115 | 110 | 104 | 96 | 88 | 71 | 58 | 50 |

For loads greater than 200 lbs ., contact Armstrong TechLine.
${ }^{1}$ Thickness and weight are nominal.

# STANDARD LOAD TABLE OPEN WEB STEEL JOISTS, H- SERIES 

Adopted by the Steel Joist Institute and American Institute of Steel Construction Inc., October 1, 1974

The black figures in the following table give the TOTAL safe uniformly distributed load-carrying capacities, in pounds per linear foot, of H -Series Steel Joists. The weight of DEAD loads, including the joists, must be deducted to determine the LIVE load-carrying capacities of the joists. The load table may be used for parallel chord joists installed to a maximum slope of $1 / 2$ inch per foot.
The figures shown in blue in this load table are the LIVE loads per linear foot of joist which will produce an approximate deflection of $1 / 360$ of the span. LIVE loads which will produce a deflection of $1 / 240$ of the span may be
obtained by multiplying the figures in blue by 1.5 . In no case shall the total load capacity of the joists be exceeded.**
Tests on steel joists designed in accordance with the Standard Specifications have demonstrated that the Standard Load Tables are applicable for concentrated top chord loadings (such as are developed in bulb-tee roof construction) when the sum of the equal concentrated top chord loadings does not exceed the allowable uniform loading for the joist type and span and the loads are placed at spacings not exceeding 33" along the top chord.

LOADS ABOVE THE COLORED LINES ARE GOVERNED BY SHEAR.

| Joist Designation | 8H3 | 10H3 | 10H4 | 12H3 | 12H4 | 12H5 | 12H6 | 14H3 | 14H4 | 14H5 | 14H6 | 14H7 | 16H4 | 16H5 | 16H6 | 16H7 | 16H8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal *Depth (in.) | 8 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 16 | 16 | 16 | 16 | 16 |
| Resist. Moment (in.-lbs.) | 91,000 | 116,000 | 148,000 | 140,000 | 180,000 | 222,000 | 260,000 | 165,000 | 212,000 | 259,000 | 307,000 | 369,000 | 221,000 | 289,000 | 344,000 | 413,000 | 478,000 |
| Max. End React. (lbs.) | 2400 | 2500 | 2800 | 2800 | 3200 | 3600 | 3900 | 3200 | 3500 | 3800 | 4200 | 4600 | 3800 | 4300 | 4600 | 4900 | 5200 |
| $\dagger$ Approx. Wt. (lbs./ft.) | 5.0 | 5.0 | 6.1 | 5.2 | 6.2 | 7.1 | 8.2 | 5.5 | 6.5 | 7.4 | 8.6 | 10.0 | 6.6 | 7.8 | 8.6 | 10.3 | 11.4 |
| Span in Feet | 600 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | 533 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | $\begin{aligned} & 480 \\ & 460 \end{aligned}$ | 500 | 560 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | $\begin{array}{r} 436 \\ 345 \end{array}$ | 455 | 509 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | $\begin{aligned} & 400 \\ & 266 \\ & \hline \end{aligned}$ | 417 | 467 | 467 | 533 | 600 | 650 |  |  |  |  |  |  |  |  |  |  |
| 13 | $\begin{aligned} & 359 \\ & 209 \end{aligned}$ | $\begin{gathered} 385 \\ 337 \end{gathered}$ | $\begin{aligned} & 431 \\ & 417 \end{aligned}$ | 431 | 492 | 554 | 600 |  |  |  |  |  |  |  |  |  |  |
| 14 | $\begin{aligned} & 201 \\ & \hline 3167 \\ & 167 \end{aligned}$ | $\begin{gathered} 357 \\ 270 \end{gathered}$ | $\begin{array}{r} 400 \\ 334 \end{array}$ | $\begin{aligned} & 400 \\ & 393 \end{aligned}$ | 457 | 514 | 557 | 457 | 500 | 543 | 600 | 657 |  |  |  |  |  |
| 15 | $\begin{gathered} 270 \\ 136 \end{gathered}$ | $\begin{array}{r}333 \\ 219 \\ \hline\end{array}$ | $\begin{gathered} 374 \\ 371 \\ 271 \end{gathered}$ | $\begin{aligned} & 373 \\ & 320 \end{aligned}$ | $\begin{gathered} 427 \\ 418 \end{gathered}$ | 480 | 520 | 427 | 467 | 507 | 560 | 613 |  |  |  |  |  |
| 16 | $\begin{aligned} & 232 \\ & 112 \end{aligned}$ | 302 181 | $\begin{aligned} & 350 \\ & 223 \end{aligned}$ | $\begin{aligned} & 350 \\ & 264 \\ & \hline \end{aligned}$ | $\begin{array}{r} 400 \\ 345 \end{array}$ | $\begin{aligned} & 450 \\ & 404 \end{aligned}$ | $\begin{aligned} & 488 \\ & 480 \end{aligned}$ | $\begin{aligned} & 400 \\ & 366 \end{aligned}$ | 438 | 475 | 525 | $5 \% 5$ | 475 | 538 | 575 | 613 | 650 |
| 17 |  | $\begin{array}{r} \hline 268 \\ 151 \end{array}$ | $\begin{gathered} 329 \\ 186 \end{gathered}$ | $\begin{aligned} & 323 \\ & 220 \end{aligned}$ | $\begin{aligned} & 376 \\ & 287 \end{aligned}$ | $\begin{array}{r} 424 \\ 337 \\ \hline \end{array}$ | $\begin{aligned} & 459 \\ & 400 \end{aligned}$ | $\begin{array}{r} 376 \\ 305 \\ \hline \end{array}$ | $\begin{aligned} & 412 \\ & 398 \\ & \hline \end{aligned}$ | 447 | 494 | 541 | 447 | 506 | 541 | 576 | 612 |
| 18 |  | 239 127 | $\begin{aligned} & 305 \\ & 157 \end{aligned}$ | $\begin{array}{r} 288 \\ 185 \end{array}$ | $\begin{aligned} & 356 \\ & 242 \end{aligned}$ | $\begin{aligned} & 400 \\ & 284 \end{aligned}$ | $\begin{aligned} & 433 \\ & 337 \end{aligned}$ | 340 <br> 257 | $\begin{aligned} & 389 \\ & 336 \\ & \hline \end{aligned}$ | 422 393 | 467 | 511 | $\begin{aligned} & 422 \\ & 413 \\ & \hline \end{aligned}$ | 478 | 511 | 544 | 578 |
| 19 |  | $\begin{aligned} & 121 \\ & \hline 214 \\ & 108 \end{aligned}$ | $\begin{array}{r} 137 \\ 273 \\ 133 \end{array}$ | $\begin{array}{r} 105 \\ 259 \\ 157 \end{array}$ | $\begin{aligned} & 232 \\ & 206 \end{aligned}$ | $\begin{gathered} 379 \\ 241 \end{gathered}$ | $\begin{aligned} & 411 \\ & 286 \end{aligned}$ | $\begin{gathered} 305 \\ 218 \end{gathered}$ | $\begin{aligned} & 368 \\ & 285 \end{aligned}$ | $\begin{aligned} & 400 \\ & 334 \end{aligned}$ | $\begin{gathered} 442 \\ 399 \end{gathered}$ | $\begin{aligned} & 484 \\ & 470 \end{aligned}$ | $\begin{aligned} & 400 \\ & 351 \end{aligned}$ | $\begin{aligned} & 453 \\ & 432 \end{aligned}$ | 484 | 516 | 547 |
| 20 |  | $\begin{array}{r} 108 \\ \hline 193 \\ 92 \end{array}$ | $247$ | 233 135 | 300 177 | $\begin{aligned} & 360 \\ & 207 \end{aligned}$ | $\begin{aligned} & 390 \\ & 246 \end{aligned}$ | $\begin{aligned} & 275 \\ & 187 \end{aligned}$ | $\begin{aligned} & 350 \\ & 245 \\ & \hline \end{aligned}$ | $\begin{aligned} & 380 \\ & 287 \end{aligned}$ | $\begin{aligned} & 420 \\ & 342 \end{aligned}$ | 460 403 | 368 301 | $\begin{aligned} & 430 \\ & 370 \end{aligned}$ | 460 437 | 490 | 520 |
| 21 |  |  |  | $\begin{aligned} & 212 \\ & 117 \end{aligned}$ | $\begin{aligned} & 172 \\ & \hline 152 \\ & \hline \end{aligned}$ | $\begin{aligned} & 336 \\ & 179 \end{aligned}$ | $\begin{aligned} & 371 \\ & 212 \end{aligned}$ | 249 162 | $\begin{gathered} 320 \\ 212 \end{gathered}$ | $\begin{aligned} & 362 \\ & 248 \end{aligned}$ | $\begin{aligned} & 400 \\ & 295 \end{aligned}$ | $\begin{array}{r} 438 \\ 348 \\ \hline \end{array}$ | $\begin{aligned} & 334 \\ & 260 \end{aligned}$ | $\begin{array}{r} 410 \\ 320 \\ \hline \end{array}$ | $\begin{aligned} & 438 \\ & 377 \\ & \hline \end{aligned}$ | $\begin{array}{r} 467 \\ 454 \\ \hline \end{array}$ | 495 |
| 22 |  |  |  | 193 101 | $\begin{gathered} 248 \\ 133 \end{gathered}$ | $\begin{aligned} & 306 \\ & 155 \end{aligned}$ | $\begin{array}{r} 355 \\ 185 \\ \hline \end{array}$ | $\begin{aligned} & 227 \\ & 141 \end{aligned}$ | $\begin{gathered} 292 \\ 184 \end{gathered}$ | $\begin{array}{r} 345 \\ 215 \\ \hline \end{array}$ | $\begin{aligned} & 382 \\ & 257 \\ & \hline \end{aligned}$ | $\begin{aligned} & 418 \\ & 302 \end{aligned}$ | $\begin{aligned} & 304 \\ & 226 \\ & \hline \end{aligned}$ | $\begin{aligned} & 391 \\ & 278 \\ & \hline \end{aligned}$ | $\begin{aligned} & 418 \\ & 328 \end{aligned}$ | 445 395 | 473 <br> 454 |
| 23 |  |  |  | 176 89 | $\begin{aligned} & 227 \\ & 116 \end{aligned}$ | $\begin{aligned} & 280 \\ & 136 \end{aligned}$ | $\begin{aligned} & 102 \\ & 328 \\ & 162 \end{aligned}$ | $\begin{aligned} & 208 \\ & 123 \end{aligned}$ | $\begin{gathered} 267 \\ 161 \end{gathered}$ | $\begin{aligned} & 326 \\ & 189 \end{aligned}$ | $\begin{aligned} & 365 \\ & 225 \end{aligned}$ | $\begin{aligned} & 4,0 \\ & 265 \\ & \hline \end{aligned}$ | $\begin{gathered} 279 \\ 198 \end{gathered}$ | $\begin{aligned} & 364 \\ & 243 \\ & \hline \end{aligned}$ | $\begin{aligned} & 400 \\ & 287 \\ & \hline \end{aligned}$ | $\begin{gathered} 426 \\ 346 \\ \hline \end{gathered}$ | $\begin{aligned} & 452 \\ & 398 \\ & \hline \end{aligned}$ |
| 24 |  |  |  | $\begin{gathered} 162 \\ 78 \end{gathered}$ | $\begin{gathered} 208 \\ 102 \end{gathered}$ | $\begin{aligned} & 257 \\ & 120 \end{aligned}$ | $\begin{aligned} & 301 \\ & 142 \end{aligned}$ | 191 | 245 142 | $\begin{aligned} & 300 \\ & 166 \end{aligned}$ | $\begin{gathered} 350 \\ 198 \\ \hline \end{gathered}$ | $\begin{aligned} & 383 \\ & 233 \end{aligned}$ | 256 174 | $\begin{array}{r} 334 \\ 214 \\ \hline \end{array}$ | $\begin{aligned} & 383 \\ & 253 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 408 \\ & 304 \\ & \hline \end{aligned}$ | $\begin{array}{r} 433 \\ 355 \\ \hline \end{array}$ |
| 25 |  |  |  |  |  |  |  | $\begin{array}{r} 100 \\ \hline 176 \\ 96 \end{array}$ | $\begin{aligned} & 226 \\ & 125 \end{aligned}$ | $\begin{gathered} 276 \\ 147 \end{gathered}$ | $\begin{aligned} & 1727 \\ & 175 \end{aligned}$ | $\begin{aligned} & 368 \\ & 206 \end{aligned}$ | $\begin{aligned} & 236 \\ & 154 \end{aligned}$ | $\begin{aligned} & 308 \\ & 190 \end{aligned}$ | $\begin{aligned} & 367 \\ & 224 \end{aligned}$ | $\begin{gathered} 392 \\ 269 \end{gathered}$ | 416 310 |
| 26 |  |  |  |  |  |  |  | $\begin{array}{r} 163 \\ 85 \end{array}$ | $\begin{gathered} 209 \\ 111 \end{gathered}$ | $\begin{gathered} 255 \\ 131 \end{gathered}$ | $\begin{aligned} & 3 J 3 \\ & 156 \end{aligned}$ | $\begin{array}{r}354 \\ 183 \\ \hline\end{array}$ | 218 137 | 285 169 | $\begin{aligned} & 339 \\ & 199 \end{aligned}$ | $\begin{array}{r} 377 \\ 239 \\ \hline \end{array}$ | 400 275 |
| 27 |  |  |  |  |  |  |  | 151 76 | 194 99 | 237 117 | $\begin{gathered} 281 \\ 139 \end{gathered}$ | $\begin{aligned} & 1337 \\ & 164 \end{aligned}$ | $\begin{aligned} & 202 \\ & 122 \end{aligned}$ | $\begin{aligned} & 264 \\ & 151 \end{aligned}$ | $\begin{aligned} & 315 \\ & 177 \end{aligned}$ | $\begin{aligned} & 363 \\ & 214 \end{aligned}$ | 385 246 |
| 28 |  |  |  |  |  |  |  | $\begin{array}{r} 140 \\ 68 \end{array}$ | $\begin{array}{r} 180 \\ 89 \end{array}$ | $\begin{aligned} & 220 \\ & 104 \end{aligned}$ | $\begin{aligned} & 261 \\ & 125 \end{aligned}$ | $\begin{aligned} & 314 \\ & 147 \end{aligned}$ | $\begin{aligned} & 188 \\ & 110 \end{aligned}$ | $\begin{array}{r} 246 \\ 135 \end{array}$ | $\begin{array}{r} 293 \\ 159 \\ \hline \end{array}$ | 350 192 | 371 220 |
| 29 |  |  |  |  |  |  |  |  |  |  |  |  | 175 99 | 229 121 | 273 143 | $\begin{aligned} & 327 \\ & 172 \end{aligned}$ | 359 198 |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  | $\begin{array}{r} 164 \\ 89 \end{array}$ | $\begin{aligned} & 214 \\ & 110 \end{aligned}$ | $\begin{aligned} & 255 \\ & 129 \end{aligned}$ | $\begin{aligned} & 336 \\ & 156 \end{aligned}$ | $\begin{array}{r}347 \\ 179 \\ \hline\end{array}$ |
| 31 |  |  |  |  |  |  |  |  |  |  |  |  | 153 81 | 200 99 | 239 117 | 287 141 | $\begin{array}{r}332 \\ 162 \\ \hline\end{array}$ |
| 32 |  |  |  |  |  |  |  |  |  |  |  |  | 144 74 | 188 90 | 224 107 | 269 128 | 311 <br> 148 |

For Joist Depths $18^{\prime \prime}$ to $22^{\prime \prime}$ inclusive

| Joist Designation | 18H5 | 18H6 | 18H7 | 18H8 | 18H9 | 18H10 | 18 H 11 | 20H5 | 20H6 | 20H7 | 20H8 | 20H9 | 20H10 | 20 H 11 | 22H6 | 22H7 | 22H8 | 22H9 | 22H10 | 22H11 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal *Depth (in.) | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 22 | 22 | 22 | 22 | 22 | 22 |


| Resist. Moment (in.-Ibs.) | 325,000 | 383,000 | 466,000 | 540,000 | 627,000 | 705,000 | 814,000 | 365,000 | 406,000 | 499,000 | 602,000 | 701,000 | 789,000 | 912,000 | 422,000 | 526,000 | 653,000 | 776,000 | 873,000 | 1,009,000 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Max. End React. <br> (lbs.) | 4500 | 4800 | 5200 | 5400 | 5900 | 6600 | 7600 | 4800 | 5100 | 5400 | 5600 | 6400 | 7000 | 7900 | 5400 | 5600 | 5800 | 6700 | 7200 | 8100 |
| $\dagger$ Approx. Wt. (lbs./ft.) | 8.0 | 9.2 | 10.4 | 11.6 | 12.6 | 14.0 | 15.8 | 8.4 | 9.6 | 10.7 | 12.2 | 13.2 | 14.6 | 16.4 | 9.7 | 10.7 | 12.0 | 13.8 | 15.2 | 16.9 |
| Span in Feet | 500 | 533 | 578 | 600 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19 | 474 | 505 | 547 | 568 | 621 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 | 450 | 480 | 520 | 540 | 590 |  |  | 480 | 510 | 540 | 560 | 640 |  |  |  |  |  |  |  |  |
| 21 | $\begin{aligned} & 429 \\ & 409 \end{aligned}$ | 457 | 495 | 514 | 562 | 629 |  | 457 | 486 | 514 | 533 | 610 |  |  |  |  |  |  |  |  |
| 22 | $\begin{aligned} & 409 \\ & 356 \end{aligned}$ | $\begin{aligned} & 436 \\ & 420 \end{aligned}$ | 473 | 491 | 536 | 600 |  | 436 | 464 | 491 | 509 | 582 | 636 |  | 491 | 509 | 527 | 609 |  |  |
| 23 | $\begin{aligned} & 391 \\ & 312 \end{aligned}$ | $\begin{aligned} & 417 \\ & 368 \end{aligned}$ | $\begin{aligned} & 452 \\ & 441 \end{aligned}$ | 470 | 513 | 574 |  | $\begin{aligned} & 417 \\ & 380 \end{aligned}$ | $\begin{aligned} & 443 \\ & 434 \end{aligned}$ | 470 | 487 | 557 | 609 |  | 470 | 487 | 504 | 583 | 626 |  |
| 24 | $\begin{aligned} & 375 \\ & 274 \end{aligned}$ | $\begin{aligned} & 400 \\ & 324 \end{aligned}$ | $\begin{aligned} & 433 \\ & 388 \end{aligned}$ | $\begin{aligned} & 450 \\ & 444 \end{aligned}$ | $\begin{aligned} & 492 \\ & 484 \end{aligned}$ | $\begin{aligned} & 550 \\ & 546 \end{aligned}$ | $\begin{aligned} & 633 \\ & 619 \end{aligned}$ | $\begin{aligned} & 400 \\ & 335 \end{aligned}$ | $\begin{aligned} & 425 \\ & 382 \end{aligned}$ | 450 | 467 | 533 | 583 |  | $\begin{aligned} & 450 \\ & 446 \end{aligned}$ | 467 | 483 | 558 | 600 |  |
| 25 | $\begin{aligned} & 347 \\ & 243 \end{aligned}$ | $\begin{aligned} & 384 \\ & 286 \end{aligned}$ | $\begin{aligned} & 416 \\ & 343 \end{aligned}$ | $\begin{aligned} & 432 \\ & 393 \end{aligned}$ | $\begin{aligned} & 472 \\ & 428 \end{aligned}$ | $\begin{aligned} & 528 \\ & 483 \end{aligned}$ | $\begin{aligned} & 608 \\ & 548 \end{aligned}$ | $\begin{aligned} & 384 \\ & 296 \end{aligned}$ | $\begin{aligned} & 408 \\ & 338 \end{aligned}$ | $\begin{aligned} & 432 \\ & 411 \end{aligned}$ | 448 | 512 | 560 | 632 | $\begin{aligned} & 432 \\ & 395 \end{aligned}$ | 448 | 464 | 536 | 576 | 648 |
| 26 | $\begin{aligned} & 321 \\ & 216 \end{aligned}$ | $\begin{aligned} & 369 \\ & 255 \end{aligned}$ | $\begin{aligned} & 400 \\ & 305 \end{aligned}$ | $\begin{aligned} & 415 \\ & 349 \end{aligned}$ | $\begin{aligned} & 454 \\ & 380 \end{aligned}$ | $\begin{aligned} & 508 \\ & 429 \end{aligned}$ | $\begin{aligned} & 585 \\ & 487 \end{aligned}$ | $\begin{aligned} & 360 \\ & 263 \end{aligned}$ | $\begin{aligned} & 392 \\ & 300 \end{aligned}$ | $\begin{aligned} & 415 \\ & 365 \end{aligned}$ | 431 | $\begin{aligned} & 492 \\ & 476 \end{aligned}$ | 538 | 608 | $\begin{aligned} & 415 \\ & 355 \end{aligned}$ | $\begin{aligned} & 431 \\ & 426 \end{aligned}$ | 446 | 515 | 554 | 623 |
| 27 | $\begin{aligned} & 297 \\ & 193 \end{aligned}$ | $\begin{aligned} & 350 \\ & 227 \end{aligned}$ | $\begin{aligned} & 385 \\ & 272 \end{aligned}$ | $\begin{aligned} & 400 \\ & 312 \end{aligned}$ | $\begin{aligned} & 437 \\ & 340 \end{aligned}$ | $\begin{aligned} & 489 \\ & 383 \end{aligned}$ | $\begin{aligned} & 563 \\ & 435 \end{aligned}$ | $\begin{aligned} & 334 \\ & 235 \end{aligned}$ | $\begin{aligned} & 371 \\ & 268 \end{aligned}$ | $\begin{aligned} & 400 \\ & 326 \end{aligned}$ | $\begin{aligned} & 415 \\ & 392 \end{aligned}$ | $\begin{aligned} & 474 \\ & 425 \end{aligned}$ | $\begin{aligned} & 519 \\ & 480 \end{aligned}$ | $\begin{aligned} & 585 \\ & 545 \end{aligned}$ | $\begin{aligned} & 386 \\ & 313 \end{aligned}$ | $\begin{aligned} & 415 \\ & 380 \end{aligned}$ | 430 | 496 | 533 | 600 |
| 28 | $\begin{aligned} & 276 \\ & 173 \end{aligned}$ | $\begin{aligned} & 326 \\ & 204 \end{aligned}$ | $\begin{aligned} & 371 \\ & 244 \end{aligned}$ | $\begin{aligned} & 386 \\ & 280 \end{aligned}$ | $\begin{aligned} & 421 \\ & 305 \\ & \hline \end{aligned}$ | $\begin{aligned} & 471 \\ & 344 \end{aligned}$ | $\begin{aligned} & 543 \\ & 390 \end{aligned}$ | $\begin{aligned} & 310 \\ & 211 \end{aligned}$ | $\begin{aligned} & 345 \\ & 240 \end{aligned}$ | $\begin{aligned} & 386 \\ & 292 \end{aligned}$ | $\begin{aligned} & 400 \\ & 352 \end{aligned}$ | $\begin{aligned} & 457 \\ & 381 \end{aligned}$ | $\begin{aligned} & 500 \\ & 431 \end{aligned}$ | $\begin{aligned} & 564 \\ & 488 \end{aligned}$ | $\begin{aligned} & 359 \\ & 281 \end{aligned}$ | $\begin{aligned} & 400 \\ & 341 \end{aligned}$ | 414 | $\begin{aligned} & 479 \\ & 468 \end{aligned}$ | 514 | 579 |
| 29 | $\begin{aligned} & 258 \\ & 155 \end{aligned}$ | $\begin{aligned} & 304 \\ & 184 \end{aligned}$ | $\begin{aligned} & 359 \\ & 220 \\ & \hline \end{aligned}$ | $\begin{aligned} & 372 \\ & 252 \end{aligned}$ | $\begin{aligned} & 407 \\ & 274 \end{aligned}$ | $\begin{aligned} & 455 \\ & 309 \end{aligned}$ | $\begin{aligned} & 524 \\ & 351 \end{aligned}$ | $\begin{aligned} & 289 \\ & 190 \end{aligned}$ | $\begin{aligned} & 322 \\ & 216 \end{aligned}$ | $\begin{aligned} & 372 \\ & 263 \end{aligned}$ | $\begin{aligned} & 386 \\ & 317 \end{aligned}$ | $\begin{aligned} & 441 \\ & 343 \end{aligned}$ | $\begin{aligned} & 483 \\ & 388 \end{aligned}$ | $\begin{aligned} & 545 \\ & 440 \end{aligned}$ | $\begin{aligned} & 335 \\ & 253 \end{aligned}$ | $\begin{aligned} & 386 \\ & 307 \end{aligned}$ | $\begin{aligned} & 400 \\ & 379 \end{aligned}$ | $\begin{aligned} & 462 \\ & 421 \end{aligned}$ | $\begin{aligned} & 497 \\ & 473 \end{aligned}$ | $\begin{aligned} & 559 \\ & 539 \end{aligned}$ |
| 30 | 241 140 | $\begin{aligned} & 284 \\ & 166 \end{aligned}$ | $\begin{aligned} & 345 \\ & 199 \end{aligned}$ | $\begin{aligned} & 360 \\ & 227 \end{aligned}$ | $\begin{aligned} & 393 \\ & 248 \end{aligned}$ | $\begin{aligned} & 440 \\ & 280 \end{aligned}$ | $\begin{aligned} & 507 \\ & 317 \end{aligned}$ | 270 171 | $\begin{aligned} & 301 \\ & 195 \end{aligned}$ | $\begin{aligned} & 360 \\ & 238 \end{aligned}$ | $\begin{aligned} & 373 \\ & 286 \end{aligned}$ | 427 310 | $\begin{aligned} & 467 \\ & 350 \end{aligned}$ | $\begin{aligned} & 527 \\ & 397 \end{aligned}$ | $\begin{aligned} & 313 \\ & 228 \end{aligned}$ | $\begin{aligned} & 373 \\ & 277 \end{aligned}$ | $\begin{aligned} & 387 \\ & 343 \end{aligned}$ | $\begin{aligned} & 447 \\ & 381 \end{aligned}$ | $\begin{aligned} & 480 \\ & 428 \end{aligned}$ | $\begin{aligned} & 540 \\ & 487 \end{aligned}$ |
| 31 | $\begin{aligned} & 225 \\ & 127 \end{aligned}$ | $\begin{aligned} & 266 \\ & 150 \end{aligned}$ | $\begin{aligned} & 323 \\ & 180 \end{aligned}$ | $\begin{aligned} & 348 \\ & 206 \end{aligned}$ | $\begin{aligned} & 381 \\ & 224 \end{aligned}$ | $\begin{aligned} & 426 \\ & 253 \end{aligned}$ | $\begin{aligned} & 490 \\ & 287 \end{aligned}$ | $\begin{aligned} & 253 \\ & 155 \end{aligned}$ | $\begin{aligned} & 282 \\ & 177 \end{aligned}$ | $\begin{aligned} & 346 \\ & 215 \end{aligned}$ | $\begin{aligned} & 361 \\ & 259 \end{aligned}$ | $\begin{aligned} & 413 \\ & 281 \end{aligned}$ | $\begin{aligned} & 452 \\ & 317 \end{aligned}$ | $\begin{aligned} & 510 \\ & 360 \end{aligned}$ | $\begin{aligned} & 293 \\ & 207 \end{aligned}$ | $\begin{aligned} & 361 \\ & 251 \end{aligned}$ | $\begin{aligned} & 374 \\ & 311 \end{aligned}$ | $\begin{aligned} & 432 \\ & 345 \end{aligned}$ | $\begin{aligned} & 465 \\ & 387 \end{aligned}$ | $\begin{aligned} & 523 \\ & 441 \end{aligned}$ |
| 32 | $\begin{aligned} & 212 \\ & 116 \end{aligned}$ | $\begin{aligned} & 249 \\ & 137 \end{aligned}$ | $\begin{aligned} & 303 \\ & 164 \end{aligned}$ | $\begin{aligned} & 338 \\ & 187 \end{aligned}$ | $\begin{aligned} & 369 \\ & 204 \end{aligned}$ | $\begin{aligned} & 413 \\ & 230 \end{aligned}$ | $\begin{aligned} & 475 \\ & 261 \end{aligned}$ | $\begin{aligned} & 238 \\ & 141 \end{aligned}$ | $\begin{aligned} & 264 \\ & 161 \end{aligned}$ | $\begin{aligned} & 325 \\ & 196 \end{aligned}$ | $\begin{aligned} & 350 \\ & 236 \end{aligned}$ | $\begin{aligned} & 400 \\ & 255 \end{aligned}$ | $\begin{aligned} & 438 \\ & 288 \end{aligned}$ | $\begin{aligned} & 494 \\ & 327 \end{aligned}$ | $\begin{aligned} & 275 \\ & 188 \end{aligned}$ | $\begin{aligned} & 342 \\ & 228 \end{aligned}$ | $\begin{aligned} & 363 \\ & 282 \end{aligned}$ | $\begin{aligned} & 419 \\ & 314 \end{aligned}$ | $\begin{aligned} & 450 \\ & 352 \end{aligned}$ | $\begin{aligned} & 506 \\ & 401 \end{aligned}$ |
| 33 | $\begin{aligned} & 199 \\ & 106 \end{aligned}$ | $\begin{aligned} & 234 \\ & 125 \end{aligned}$ | $\begin{aligned} & 285 \\ & 149 \end{aligned}$ | $\begin{aligned} & 327 \\ & 171 \end{aligned}$ | $\begin{aligned} & 358 \\ & 186 \end{aligned}$ | $\begin{aligned} & 400 \\ & 210 \end{aligned}$ | $\begin{aligned} & 461 \\ & 238 \end{aligned}$ | $\begin{aligned} & 223 \\ & 129 \end{aligned}$ | $\begin{aligned} & 249 \\ & 147 \end{aligned}$ | $\begin{aligned} & 305 \\ & 178 \\ & \hline \end{aligned}$ | $\begin{aligned} & 339 \\ & 215 \\ & \hline \end{aligned}$ | $\begin{aligned} & 388 \\ & 233 \end{aligned}$ | $\begin{aligned} & 424 \\ & 263 \\ & \hline \end{aligned}$ | $\begin{aligned} & 479 \\ & 298 \\ & \hline \end{aligned}$ | $\begin{aligned} & 258 \\ & 172 \\ & \hline \end{aligned}$ | $\begin{aligned} & 322 \\ & 208 \\ & \hline \end{aligned}$ | $\begin{aligned} & 352 \\ & 257 \\ & \hline \end{aligned}$ | $\begin{aligned} & 406 \\ & 286 \\ & \hline \end{aligned}$ | $\begin{aligned} & 436 \\ & 321 \end{aligned}$ | $\begin{aligned} & 491 \\ & 366 \end{aligned}$ |
| 34 | $\begin{gathered} 187 \\ 96 \end{gathered}$ | 221 114 | $\begin{aligned} & 269 \\ & 136 \end{aligned}$ | $\begin{aligned} & 311 \\ & 156 \end{aligned}$ | $\begin{aligned} & 347 \\ & 170 \end{aligned}$ | $\begin{aligned} & 388 \\ & 192 \end{aligned}$ | $\begin{aligned} & 447 \\ & 218 \end{aligned}$ | 210 118 | $\begin{aligned} & 234 \\ & 134 \end{aligned}$ | $\begin{aligned} & 288 \\ & 163 \end{aligned}$ | $\begin{aligned} & 329 \\ & 196 \end{aligned}$ | $\begin{aligned} & 376 \\ & 213 \end{aligned}$ | 412 240 | $\begin{aligned} & 465 \\ & 273 \end{aligned}$ | 243 157 | $\begin{aligned} & 303 \\ & 190 \end{aligned}$ | 341 235 | $\begin{aligned} & 394 \\ & 261 \end{aligned}$ | $\begin{aligned} & 424 \\ & 294 \end{aligned}$ | $\begin{aligned} & 476 \\ & 335 \end{aligned}$ |
| 35 | 177 88 | 208 104 | $\begin{aligned} & 254 \\ & 125 \end{aligned}$ | $\begin{aligned} & 294 \\ & 143 \end{aligned}$ | $\begin{aligned} & 337 \\ & 156 \end{aligned}$ | $\begin{aligned} & 377 \\ & 176 \end{aligned}$ | $\begin{aligned} & 434 \\ & 200 \end{aligned}$ | $\begin{aligned} & 199 \\ & 108 \end{aligned}$ | $\begin{aligned} & 221 \\ & 123 \end{aligned}$ | $\begin{aligned} & 272 \\ & 150 \end{aligned}$ | $\begin{aligned} & 320 \\ & 180 \end{aligned}$ | $\begin{aligned} & 366 \\ & 195 \end{aligned}$ | $\begin{aligned} & 400 \\ & 220 \end{aligned}$ | $\begin{aligned} & 451 \\ & 250 \end{aligned}$ | $\begin{aligned} & 230 \\ & 144 \end{aligned}$ | 286 175 | $\begin{aligned} & 331 \\ & 216 \end{aligned}$ | $\begin{aligned} & 383 \\ & 240 \end{aligned}$ | 4269 | $\begin{aligned} & 463 \\ & 307 \end{aligned}$ |
| 36 | $\begin{array}{r} 167 \\ 81 \end{array}$ | $\begin{array}{r} 197 \\ 96 \\ \hline \end{array}$ | $\begin{aligned} & 240 \\ & 115 \\ & \hline \end{aligned}$ | $\begin{aligned} & 278 \\ & 132 \end{aligned}$ | $\begin{aligned} & 323 \\ & 143 \end{aligned}$ | $\begin{aligned} & 363 \\ & 162 \end{aligned}$ | $\begin{aligned} & 419 \\ & 183 \end{aligned}$ | $\begin{gathered} 188 \\ 99 \end{gathered}$ | $\begin{aligned} & 209 \\ & 113 \end{aligned}$ | $\begin{aligned} & 257 \\ & 137 \end{aligned}$ | $\begin{aligned} & 310 \\ & 166 \end{aligned}$ | $\begin{aligned} & 356 \\ & 179 \end{aligned}$ | $\begin{aligned} & 389 \\ & 203 \end{aligned}$ | $\begin{aligned} & 439 \\ & 230 \end{aligned}$ | $\begin{aligned} & 217 \\ & 132 \end{aligned}$ | $\begin{aligned} & 271 \\ & 160 \end{aligned}$ | $\begin{aligned} & 322 \\ & 198 \end{aligned}$ | $\begin{aligned} & 372 \\ & 220 \end{aligned}$ | $\begin{aligned} & 400 \\ & 247 \end{aligned}$ | $\begin{aligned} & 450 \\ & 282 \end{aligned}$ |
| 37 |  |  |  |  |  |  |  | $\begin{gathered} 178 \\ 91 \end{gathered}$ | $\begin{aligned} & 198 \\ & 104 \end{aligned}$ | $\begin{aligned} & 243 \\ & 127 \end{aligned}$ | $\begin{aligned} & 293 \\ & 152 \end{aligned}$ | $\begin{aligned} & 341 \\ & 165 \end{aligned}$ | $\begin{aligned} & 378 \\ & 187 \\ & \hline \end{aligned}$ | $\begin{aligned} & 427 \\ & 212 \end{aligned}$ | $\begin{aligned} & 206 \\ & 122 \\ & \hline \end{aligned}$ | $\begin{aligned} & 256 \\ & 148 \end{aligned}$ | $\begin{aligned} & \hline 314 \\ & 183 \\ & \hline \end{aligned}$ | $\begin{aligned} & 362 \\ & 203 \end{aligned}$ | $\begin{aligned} & 389 \\ & 228 \\ & \hline \end{aligned}$ | $\begin{array}{r} 438 \\ 260 \\ \hline \end{array}$ |
| 38 |  |  |  |  |  |  |  | $\begin{gathered} 169 \\ 84 \end{gathered}$ | $\begin{aligned} & 187 \\ & 96 \end{aligned}$ | $\begin{aligned} & 230 \\ & 117 \end{aligned}$ | $\begin{aligned} & 278 \\ & 141 \end{aligned}$ | 324 153 | $\begin{aligned} & 364 \\ & 172 \end{aligned}$ | $\begin{aligned} & 416 \\ & 195 \end{aligned}$ | $\begin{aligned} & 195 \\ & 112 \end{aligned}$ | 243 136 | $\begin{aligned} & 301 \\ & 169 \end{aligned}$ | $\begin{aligned} & 353 \\ & 187 \end{aligned}$ | $\begin{aligned} & 379 \\ & 210 \end{aligned}$ | $\begin{aligned} & 426 \\ & 240 \end{aligned}$ |
| 39 |  |  |  |  |  |  |  | $\begin{array}{r} 160 \\ 78 \end{array}$ | $\begin{array}{r} 178 \\ 89 \end{array}$ | $\begin{aligned} & 219 \\ & 108 \end{aligned}$ | $\begin{aligned} & 264 \\ & 130 \end{aligned}$ | $\begin{aligned} & 307 \\ & 141 \end{aligned}$ | $\begin{aligned} & 346 \\ & 159 \end{aligned}$ | $\begin{aligned} & 400 \\ & 181 \end{aligned}$ | $\begin{aligned} & 185 \\ & 104 \end{aligned}$ | $\begin{aligned} & 231 \\ & 126 \end{aligned}$ | $\begin{aligned} & 286 \\ & 156 \end{aligned}$ | $\begin{aligned} & 340 \\ & 173 \end{aligned}$ | $\begin{aligned} & 369 \\ & 195 \end{aligned}$ | $\begin{aligned} & 415 \\ & 222 \end{aligned}$ |
| 40 |  |  |  |  |  |  |  | $\begin{array}{r} 152 \\ 72 \end{array}$ | $\begin{array}{r} 169 \\ 82 \end{array}$ | $\begin{aligned} & 208 \\ & 100 \end{aligned}$ | $\begin{aligned} & 251 \\ & 121 \end{aligned}$ | $\begin{aligned} & 292 \\ & 131 \end{aligned}$ | $\begin{aligned} & 329 \\ & 148 \end{aligned}$ | $\begin{aligned} & 380 \\ & 168 \end{aligned}$ | $\begin{gathered} 176 \\ 96 \end{gathered}$ | $\begin{aligned} & 219 \\ & 117 \end{aligned}$ | $\begin{aligned} & 272 \\ & 145 \end{aligned}$ | $\begin{aligned} & 323 \\ & 161 \end{aligned}$ | $\begin{aligned} & 360 \\ & 180 \end{aligned}$ | $\begin{aligned} & 405 \\ & 205 \end{aligned}$ |
| 41 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | $\begin{array}{r} 167 \\ 89 \end{array}$ | $\begin{aligned} & 209 \\ & 109 \end{aligned}$ | $\begin{aligned} & 259 \\ & 134 \end{aligned}$ | $\begin{aligned} & 308 \\ & 149 \end{aligned}$ | $\begin{aligned} & 346 \\ & 167 \end{aligned}$ | $\begin{aligned} & 395 \\ & 191 \end{aligned}$ |
| 42 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | $\begin{array}{r} 159 \\ 83 \\ \hline \end{array}$ | $\begin{aligned} & 199 \\ & 101 \end{aligned}$ | $\begin{aligned} & 247 \\ & 125 \end{aligned}$ | $\begin{aligned} & 293 \\ & 139 \end{aligned}$ | $\begin{array}{r} 330 \\ 156 \\ \hline \end{array}$ | 381 <br> 177 |
| 43 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 152 78 | 190 94 | 235 116 | ${ }_{129}^{280}$ | $\begin{aligned} & 315 \\ & 145 \\ & \hline \end{aligned}$ | 364 165 |
| 44 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 145 72 | 181 88 | $\begin{aligned} & 225 \\ & 109 \end{aligned}$ | 267 121 | 301 136 | 347 <br> 154 |

*Indicates Nominal Depth of steel joists only.
$\dagger$ Approximate Weights per Linear Foot of steel joists only. Accessories and nailer strip not included.
*†See manufacturers' catalog for detailed information on specific joist types.
**Section 5.9 of the "Standard Specifications for Open Web Steel Joists, J- and H-Series" limits the design LIVE load deflection as follows:
FLOORS, $1 / 360$ span. ROOFS, $1 / 360$ of span where a plaster ceiling is attached or suspended: $1 / 240$ of span for all other cases.

For Joist Depths 24" to 30" inclusive

| Joist Designation | 24H6 | 24H7 | 24H8 | 24H9 | 24H10 | 24 H 11 | 26 H 8 | 26H9 | 26H10 | 26H11 | $28 \mathrm{H8}$ | $28 \mathrm{H9}$ | 28 H 10 | 28 H 11 | 30H8 | 30H9 | 30 H 10 | 30 H 11 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal *Depth (in.) | 24 | 24 | 24 | 24 | 24 | 24 | 26 | 26 | 26 | 26 | 28 | 28 | 28 | 28 | 30 | 30 | 30 | 30 |
| Resist. Moment (in.-lbs.) | 462,000 | 576,000 | 716,000 | 851,000 | 957,000 | 1,106,000 | 784,000 | 925,000 | 1,040,000 | 1,203,000 | 846,000 | 1,000,000 | 1,124,000 | 1,300,000 | 909,000 | 1,075,000 | 1,207,000 | 1,397,000 |
| Max. End React. (lbs.) | 5600 | 5800 | 6000 | 7000 | 7500 | 8200 | 6700 | 7200 | 7600 | 8300 | 6700 | 7200 | 7700 | 8400 | 6800 | 7500 | 8100 | 8700 |
| $\begin{gathered} \dagger \text { Approx. Wt. } \\ \text { (Ibs./ft.) } \end{gathered}$ | 10.3 | 11.5 | 12.7 | 14.0 | 15.5 | 17.5 | 12.8 | 14.8 | 16.2 | 17.9 | 13.5 | 15.2 | 16.8 | 18.3 | 14.2 | 15.4 | 17.3 | 18.8 |
| $\begin{gathered} \text { Span in Feet } \\ 24 \\ \hline \end{gathered}$ | 467 | 483 | 500 | 583 | 625 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25 | 448 | 464 | 480 | 560 | 600 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 26 | 431 | 446 | 462 | 538 | 577 | 631 | 515 | 554 | 585 | 638 |  |  |  |  |  |  |  |  |
| 27 | $\begin{gathered} 415 \\ 375 \\ \hline \end{gathered}$ | 430 | 444 | 519 | 556 | 607 | 496 | 533 | 563 | 615 |  |  |  |  |  |  |  |  |
| 28 | $\begin{array}{r} 393 \\ 336 \\ \hline \end{array}$ | $\begin{gathered} 414 \\ 406 \\ \hline \end{gathered}$ | 429 | 500 | 536 | 586 | 479 | 514 | 543 | 593 | 479 | 514 | 550 | 600 |  |  |  |  |
| 29 | $\begin{aligned} & 366 \\ & 303 \\ & \hline \end{aligned}$ | $\begin{array}{r} 400 \\ 365 \\ \hline \end{array}$ | 414 | 483 | 517 | 566 | 462 | 497 | 524 | 572 | 462 | 497 | 531 | 579 |  |  |  |  |
| 30 | $\begin{aligned} & 342 \\ & 273 \\ & \hline \end{aligned}$ | $\begin{array}{r} 387 \\ 330 \\ \hline \end{array}$ | 400 | $\begin{aligned} & 467 \\ & 457 \\ & \hline \end{aligned}$ | 500 | 547 | 447 | 480 | 507 | 553 | 447 | 480 | 513 | 560 | 453 | 500 | 540 | 580 |
| 31 | $\begin{aligned} & 320 \\ & 248 \\ & \hline \end{aligned}$ | $\begin{array}{r} 374 \\ \hline 299 \end{array}$ | $\begin{array}{r} 387 \\ 373 \\ \hline \end{array}$ | $\begin{array}{r} 452 \\ 414 \\ \hline \end{array}$ | $\begin{array}{r} 484 \\ 465 \\ \hline \end{array}$ | 529 | $\begin{gathered} 432 \\ 418 \\ \hline \end{gathered}$ | 465 | 490 | 535 | 432 | 465 | 497 | 542 | 439 | 484 | 523 | 561 |
| 32 | $\begin{aligned} & 301 \\ & 225 \\ & \hline \end{aligned}$ | $\begin{aligned} & 363 \\ & 272 \\ & \hline \end{aligned}$ | $\begin{aligned} & 375 \\ & 339 \end{aligned}$ | $\begin{array}{r} 438 \\ 376 \\ \hline \end{array}$ | $\begin{aligned} & \hline 469 \\ & 423 \\ & \hline \end{aligned}$ | $\begin{aligned} & 513 \\ & 482 \\ & \hline \end{aligned}$ | $\begin{array}{r} 419 \\ 380 \\ \hline \end{array}$ | $\begin{array}{r} 450 \\ 445 \\ \hline \end{array}$ | 475 | 519 | 419 | 450 | 481 | 525 | 425 | 469 | 506 | 544 |
| 33 | $\begin{aligned} & 283 \\ & 205 \\ & \hline \end{aligned}$ | $\begin{gathered} 352 \\ 248 \\ \hline \end{gathered}$ | $\begin{gathered} 364 \\ 309 \end{gathered}$ | $\begin{gathered} \hline 424 \\ 343 \\ \hline \end{gathered}$ | $\begin{array}{r} 455 \\ 386 \\ \hline \end{array}$ | $\begin{gathered} 497 \\ 440 \\ \hline \end{gathered}$ | $\begin{gathered} 406 \\ 346 \\ \hline \end{gathered}$ | $\begin{gathered} 436 \\ 405 \\ \hline \end{gathered}$ | $\begin{array}{r} \hline 461 \\ 456 \\ \hline \end{array}$ | 503 | $\begin{array}{r} 406 \\ 404 \\ \hline \end{array}$ | 436 | 467 | 509 | 412 | 455 | 491 | 527 |
| 34 | $\begin{gathered} 266 \\ 188 \\ \hline \end{gathered}$ | $\begin{aligned} & 332 \\ & 227 \\ & \hline \end{aligned}$ | $\begin{array}{r} 353 \\ 283 \\ \hline \end{array}$ | $\begin{array}{r} 412 \\ 314 \\ \hline \end{array}$ | $\begin{array}{r} 441 \\ 353 \\ \hline \end{array}$ | $\begin{gathered} 482 \\ 402 \\ \hline \end{gathered}$ | $\begin{array}{r} 394 \\ 317 \end{array}$ | $\begin{array}{r} 424 \\ 371 \end{array}$ | $\begin{gathered} 447 \\ 417 \end{gathered}$ | $\begin{array}{r} 488 \\ 476 \\ \hline \end{array}$ | $\begin{array}{r} 394 \\ 370 \\ \hline \end{array}$ | 424 | 453 | 494 | 400 | 441 | 476 | 512 |
| 35 | $\begin{gathered} 251 \\ 172 \\ \hline \end{gathered}$ | $\begin{aligned} & 313 \\ & 208 \\ & \hline \end{aligned}$ | $\begin{array}{r} 343 \\ 259 \\ \hline \end{array}$ | $\begin{array}{r} 400 \\ 288 \\ \hline \end{array}$ | $\begin{array}{r} 429 \\ 323 \\ \hline \end{array}$ | $\begin{gathered} \hline 469 \\ 369 \\ \hline \end{gathered}$ | $\begin{array}{r} 383 \\ 290 \\ \hline \end{array}$ | $\begin{array}{r} 411 \\ 340 \\ \hline \end{array}$ | $\begin{gathered} 434 \\ 383 \end{gathered}$ | $\begin{array}{r} \hline 474 \\ 437 \\ \hline \end{array}$ | $\begin{array}{r} 383 \\ 339 \\ \hline \end{array}$ | $\begin{array}{r} \hline 411 \\ 396 \\ \hline \end{array}$ | 440 | 480 | 389 | 429 | 463 | 497 |
| 36 | $\begin{aligned} & 238 \\ & 158 \\ & \hline \end{aligned}$ | $\begin{gathered} 296 \\ 191 \\ \hline \end{gathered}$ | $\begin{aligned} & 333 \\ & 238 \\ & \hline \end{aligned}$ | $\begin{gathered} 389 \\ 264 \\ \hline \end{gathered}$ | $\begin{array}{r} 417 \\ 297 \\ \hline \end{array}$ | $\begin{array}{r} 456 \\ 339 \\ \hline \end{array}$ | $\begin{gathered} 372 \\ 267 \\ \hline \end{gathered}$ | $\begin{array}{r} 400 \\ 312 \\ \hline \end{array}$ | $\begin{gathered} 422 \\ 352 \\ \hline \end{gathered}$ | $\begin{gathered} 461 \\ 401 \\ \hline \end{gathered}$ | $\begin{gathered} 372 \\ 311 \end{gathered}$ | $\begin{gathered} 400 \\ 364 \\ \hline \end{gathered}$ | $\begin{gathered} 428 \\ 410 \\ \hline \end{gathered}$ | 467 | $\begin{array}{r} 378 \\ 359 \\ \hline \end{array}$ | 417 | 450 | 483 |
| 37 | $\begin{gathered} 225 \\ 146 \end{gathered}$ | $\begin{gathered} 280 \\ 176 \\ \hline \end{gathered}$ | $\begin{array}{r} 324 \\ 219 \\ \hline \end{array}$ | $\begin{aligned} & 378 \\ & 243 \end{aligned}$ | $\begin{array}{r} 405 \\ 274 \end{array}$ | $\begin{array}{r} 443 \\ 312 \\ \hline \end{array}$ | $\begin{aligned} & 362 \\ & 246 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 389 \\ & 288 \\ & \hline \end{aligned}$ | $\begin{aligned} & 411 \\ & 324 \\ & \hline \end{aligned}$ | $\begin{gathered} 449 \\ 370 \\ \hline \end{gathered}$ | $\begin{aligned} & 362 \\ & 287 \end{aligned}$ | $\begin{array}{r} 389 \\ 336 \\ \hline \end{array}$ | $\begin{gathered} 416 \\ 378 \\ \hline \end{gathered}$ | $\begin{array}{r} 454 \\ 432 \\ \hline \end{array}$ | $\begin{array}{r} 368 \\ 330 \\ \hline \end{array}$ | $\begin{array}{r} 405 \\ 387 \\ \hline \end{array}$ | $\begin{array}{r} 438 \\ 436 \\ \hline \end{array}$ | 470 |
| 38 | $\begin{gathered} 213 \\ 135 \\ \hline \end{gathered}$ | $\begin{gathered} 266 \\ 162 \\ \hline \end{gathered}$ | $\begin{aligned} & 316 \\ & 202 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 368 \\ & 225 \\ & \hline \end{aligned}$ | $\begin{array}{r} 395 \\ 253 \\ \hline \end{array}$ | $\begin{array}{r} 432 \\ 288 \\ \hline \end{array}$ | $\begin{aligned} & 353 \\ & 227 \end{aligned}$ | $\begin{aligned} & 379 \\ & 266 \\ & \hline \end{aligned}$ | $\begin{array}{r} 400 \\ 299 \\ \hline \end{array}$ | $\begin{array}{r} 437 \\ 341 \\ \hline \end{array}$ | $\begin{array}{r} 353 \\ 265 \\ \hline \end{array}$ | $\begin{array}{r} 379 \\ 310 \\ \hline \end{array}$ | $\begin{array}{r} 405 \\ 349 \\ \hline \end{array}$ | $\begin{array}{r} 442 \\ 399 \\ \hline \end{array}$ | $\begin{array}{r} 358 \\ 305 \\ \hline \end{array}$ | $\begin{array}{r} 395 \\ 357 \\ \hline \end{array}$ | $\begin{aligned} & \hline 426 \\ & 402 \\ & \hline \end{aligned}$ | 458 |
| 39 | $\begin{array}{r} 202 \\ 124 \\ \hline \end{array}$ | $\begin{array}{r} 252 \\ 150 \\ \hline \end{array}$ | $\begin{gathered} 308 \\ 187 \\ \hline \end{gathered}$ | $\begin{array}{r} 359 \\ 208 \\ \hline \end{array}$ | $\begin{aligned} & 385 \\ & 234 \\ & \hline \end{aligned}$ | $\begin{array}{r} 421 \\ 266 \\ \hline \end{array}$ | $\begin{array}{r} 344 \\ 210 \\ \hline \end{array}$ | $\begin{aligned} & 369 \\ & 246 \\ & \hline \end{aligned}$ | $\begin{aligned} & 390 \\ & 276 \\ & \hline \end{aligned}$ | $\begin{aligned} & 426 \\ & 316 \\ & \hline \end{aligned}$ | $\begin{array}{r} 344 \\ 245 \\ \hline \end{array}$ | $\begin{array}{r} 369 \\ 287 \\ \hline \end{array}$ | $\begin{aligned} & 395 \\ & 322 \\ & \hline \end{aligned}$ | $\begin{array}{r} 431 \\ 369 \\ \hline \end{array}$ | $\begin{aligned} & \hline 349 \\ & 282 \\ & \hline \end{aligned}$ | $\begin{array}{r} 385 \\ 331 \\ \hline \end{array}$ | $\begin{array}{r} 415 \\ 372 \\ \hline \end{array}$ | $\begin{aligned} & \hline 446 \\ & 426 \\ & \hline \end{aligned}$ |
| 40 | $\begin{aligned} & 193 \\ & 115 \\ & \hline \end{aligned}$ | $\begin{array}{r} 240 \\ 139 \\ \hline \end{array}$ | $\begin{aligned} & 298 \\ & 174 \\ & \hline \end{aligned}$ | $\begin{aligned} & 350 \\ & 193 \end{aligned}$ | $\begin{array}{r} 375 \\ 217 \\ \hline \end{array}$ | $\begin{array}{r} 410 \\ 247 \\ \hline \end{array}$ | $\begin{array}{r} 327 \\ 194 \\ \hline \end{array}$ | $\begin{aligned} & 360 \\ & 228 \end{aligned}$ | $\begin{array}{r} 380 \\ 256 \\ \hline \end{array}$ | $\begin{array}{r} 415 \\ 292 \\ \hline \end{array}$ | $\begin{array}{r} 335 \\ 227 \\ \hline \end{array}$ | $\begin{array}{r} 360 \\ 266 \\ \hline \end{array}$ | $\begin{array}{r} 385 \\ 299 \\ \hline \end{array}$ | $\begin{array}{r} 420 \\ 342 \\ \hline \end{array}$ | $\begin{aligned} & 340 \\ & 262 \\ & \hline \end{aligned}$ | $\begin{array}{r} 375 \\ 306 \\ \hline \end{array}$ | $\begin{array}{r} 405 \\ 345 \\ \hline \end{array}$ | $\begin{array}{r} 435 \\ 395 \\ \hline \end{array}$ |
| 41 | $\begin{aligned} & 183 \\ & 107 \\ & \hline \end{aligned}$ | $\begin{gathered} 228 \\ 129 \\ \hline \end{gathered}$ | $\begin{array}{r} 284 \\ 161 \\ \hline \end{array}$ | $\begin{aligned} & 337 \\ & 179 \\ & \hline \end{aligned}$ | $\begin{aligned} & 366 \\ & 201 \\ & \hline \end{aligned}$ | $\begin{array}{r} 400 \\ 229 \\ \hline \end{array}$ | $\begin{gathered} \hline 311 \\ 181 \\ \hline \end{gathered}$ | $\begin{aligned} & 351 \\ & 211 \end{aligned}$ | $\begin{aligned} & 371 \\ & 238 \\ & \hline \end{aligned}$ | $\begin{array}{r} 405 \\ 272 \\ \hline \end{array}$ | $\begin{aligned} & 327 \\ & 211 \end{aligned}$ | $\begin{aligned} & 351 \\ & 247 \end{aligned}$ | $\begin{aligned} & 376 \\ & 278 \\ & \hline \end{aligned}$ | $\begin{aligned} & 410 \\ & 318 \\ & \hline \end{aligned}$ | $\begin{array}{r} 332 \\ 243 \\ \hline \end{array}$ | $\begin{array}{r} 366 \\ 285 \\ \hline \end{array}$ | $\begin{array}{r} 395 \\ 320 \\ \hline \end{array}$ | $\begin{array}{r} 424 \\ 367 \\ \hline \end{array}$ |
| 42 | $\begin{aligned} & 175 \\ & 100 \\ & \hline \end{aligned}$ | $\begin{aligned} & 218 \\ & 120 \end{aligned}$ | $\begin{array}{r} 271 \\ 150 \\ \hline \end{array}$ | $\begin{gathered} 322 \\ 166 \\ \hline \end{gathered}$ | $\begin{aligned} & 357 \\ & 187 \\ & \hline \end{aligned}$ | $\begin{array}{r} 390 \\ 213 \\ \hline \end{array}$ | $\begin{gathered} \hline 296 \\ 168 \\ \hline \end{gathered}$ | $\begin{gathered} \hline 343 \\ 197 \\ \hline \end{gathered}$ | $\begin{array}{r} 362 \\ 221 \\ \hline \end{array}$ | $\begin{array}{r} 395 \\ 253 \\ \hline \end{array}$ | $\begin{aligned} & 319 \\ & 196 \\ & \hline \end{aligned}$ | $\begin{array}{r} 343 \\ 229 \\ \hline \end{array}$ | $\begin{aligned} & 367 \\ & 258 \\ & \hline \end{aligned}$ | $\begin{array}{r} 400 \\ 295 \\ \hline \end{array}$ | $\begin{aligned} & 324 \\ & 226 \\ & \hline \end{aligned}$ | $\begin{array}{r} 357 \\ 265 \\ \hline \end{array}$ | $\begin{aligned} & 386 \\ & 298 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 414 \\ & 341 \\ & \hline \end{aligned}$ |
| 43 | $\begin{array}{r} 167 \\ 93 \\ \hline \end{array}$ | $\begin{aligned} & 208 \\ & 112 \\ & \hline \end{aligned}$ | $\begin{aligned} & 258 \\ & 140 \end{aligned}$ | $\begin{array}{r} 307 \\ 155 \\ \hline \end{array}$ | $\begin{aligned} & 345 \\ & 174 \end{aligned}$ | $\begin{array}{r} 381 \\ 199 \\ \hline \end{array}$ | $\begin{gathered} 283 \\ 156 \\ \hline \end{gathered}$ | $\begin{aligned} & 334 \\ & 183 \\ & \hline \end{aligned}$ | $\begin{array}{r} 353 \\ 206 \\ \hline \end{array}$ | $\begin{array}{r} 386 \\ 235 \\ \hline \end{array}$ | $\begin{array}{r} 305 \\ 183 \\ \hline \end{array}$ | $\begin{array}{r} 335 \\ 214 \\ \hline \end{array}$ | $\begin{array}{r} 358 \\ 241 \\ \hline \end{array}$ | $\begin{array}{r} 391 \\ 275 \\ \hline \end{array}$ | $\begin{array}{r} 316 \\ 211 \\ \hline \end{array}$ | $\begin{array}{r} 349 \\ 247 \\ \hline \end{array}$ | $\begin{aligned} & 377 \\ & 278 \\ & \hline \end{aligned}$ | $\begin{aligned} & 405 \\ & 318 \\ & \hline \end{aligned}$ |
| 44 | $\begin{array}{r} 159 \\ 87 \\ \hline \end{array}$ | $\begin{aligned} & 198 \\ & 105 \end{aligned}$ | $\begin{gathered} 247 \\ 130 \end{gathered}$ | $\begin{gathered} 293 \\ 145 \end{gathered}$ | $\begin{gathered} 330 \\ 163 \end{gathered}$ | $\begin{gathered} 373 \\ 186 \\ \hline \end{gathered}$ | $\begin{gathered} 270 \\ 146 \end{gathered}$ | $319$ | $\begin{aligned} & \hline 345 \\ & 193 \\ & \hline \end{aligned}$ | $\begin{array}{r} 377 \\ 220 \\ \hline \end{array}$ | $\begin{gathered} 291 \\ 171 \\ \hline \end{gathered}$ | $\begin{aligned} & 327 \\ & 200 \\ & \hline \end{aligned}$ | $\begin{aligned} & 350 \\ & 225 \\ & \hline \end{aligned}$ | $\begin{array}{r} 382 \\ 257 \\ \hline \end{array}$ | $\begin{aligned} & 309 \\ & 196 \\ & \hline \end{aligned}$ | $\begin{array}{r} 341 \\ 230 \\ \hline \end{array}$ | $\begin{array}{r} 368 \\ 259 \\ \hline \end{array}$ | $\begin{array}{r} 395 \\ 297 \\ \hline \end{array}$ |
| 45 | $\begin{array}{r} 152 \\ 81 \\ \hline \end{array}$ | $\begin{array}{r} 190 \\ 98 \\ \hline \end{array}$ | $\begin{aligned} & 236 \\ & 122 \end{aligned}$ | $\begin{array}{r} 280 \\ 135 \end{array}$ | $\begin{aligned} & 315 \\ & 152 \\ & \hline \end{aligned}$ | $\begin{aligned} & 364 \\ & 173 \\ & \hline \end{aligned}$ | $\begin{array}{r} 258 \\ 137 \\ \hline \end{array}$ | $\begin{aligned} & 305 \\ & 160 \\ & \hline \end{aligned}$ | $\begin{aligned} & 338 \\ & 180 \\ & \hline \end{aligned}$ | $\begin{aligned} & 369 \\ & 205 \\ & \hline \end{aligned}$ | $\begin{array}{r} 279 \\ 159 \\ \hline \end{array}$ | $\begin{array}{r} 320 \\ 187 \\ \hline \end{array}$ | $\begin{aligned} & 342 \\ & 210 \\ & \hline \end{aligned}$ | $\begin{array}{r} 373 \\ 240 \\ \hline \end{array}$ | $\begin{aligned} & 299 \\ & 184 \\ & \hline \end{aligned}$ | $\begin{array}{r} 333 \\ 215 \\ \hline \end{array}$ | $\begin{array}{r} 360 \\ 242 \\ \hline \end{array}$ | $\begin{array}{r} 387 \\ 278 \\ \hline \end{array}$ |
| 46 | 146 76 | 181 92 | 226 114 | $\begin{aligned} & 268 \\ & 127 \end{aligned}$ | $\begin{aligned} & 302 \\ & 142 \end{aligned}$ | $\begin{aligned} & 348 \\ & 162 \\ & \hline \end{aligned}$ | $\begin{gathered} 247 \\ 128 \\ \hline \end{gathered}$ | $\begin{gathered} 291 \\ 150 \\ \hline \end{gathered}$ | $\begin{aligned} & \hline 328 \\ & 168 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 361 \\ & 192 \\ & \hline \end{aligned}$ | $\begin{array}{r} 267 \\ 149 \\ \hline \end{array}$ | $\begin{aligned} & 313 \\ & 175 \\ & \hline \end{aligned}$ | $\begin{array}{r} 335 \\ 197 \\ \hline \end{array}$ | $\begin{array}{r} 365 \\ 225 \\ \hline \end{array}$ | $\begin{array}{r} 286 \\ 172 \\ \hline \end{array}$ | $\begin{array}{r} 326 \\ 202 \\ \hline \end{array}$ | $\begin{array}{r} 352 \\ 227 \\ \hline \end{array}$ | 378 <br> 260 |
| 47 | $\begin{array}{r} 139 \\ 71 \\ \hline \end{array}$ | $\begin{array}{r} 174 \\ 86 \\ \hline \end{array}$ | $\begin{gathered} \hline 216 \\ 107 \\ \hline \end{gathered}$ | $\begin{gathered} 257 \\ 119 \\ \hline \end{gathered}$ | $\begin{gathered} 289 \\ 133 \\ \hline \end{gathered}$ | $\begin{array}{r} 334 \\ 152 \\ \hline \end{array}$ | $\begin{array}{r} 237 \\ 120 \\ \hline \end{array}$ | $\begin{gathered} 279 \\ 140 \end{gathered}$ | $\begin{aligned} & \hline 314 \\ & 158 \\ & \hline \end{aligned}$ | $\begin{aligned} & 353 \\ & 180 \\ & \hline \end{aligned}$ | $\begin{array}{r} 255 \\ 140 \\ \hline \end{array}$ | $\begin{aligned} & 302 \\ & 164 \\ & \hline \end{aligned}$ | $\begin{array}{r} 328 \\ 184 \\ \hline \end{array}$ | $\begin{array}{r} 357 \\ 211 \\ \hline \end{array}$ | $\begin{array}{r} 274 \\ 161 \\ \hline \end{array}$ | 319 189 | 345 213 | 370 244 |
| 48 | $\begin{array}{r} 134 \\ 67 \\ \hline \end{array}$ | $\begin{array}{r} 167 \\ 81 \\ \hline \end{array}$ | $\begin{gathered} 207 \\ 100 \\ \hline \end{gathered}$ | $\begin{gathered} 246 \\ 111 \\ \hline \end{gathered}$ | $\begin{gathered} 277 \\ 125 \\ \hline \end{gathered}$ | $\begin{gathered} 320 \\ 143 \\ \hline \end{gathered}$ | $\begin{aligned} & \hline 227 \\ & 112 \end{aligned}$ | $\begin{gathered} 268 \\ 132 \\ \hline \end{gathered}$ | $\begin{gathered} 301 \\ 148 \\ \hline \end{gathered}$ | $\begin{aligned} & 346 \\ & 169 \\ & \hline \end{aligned}$ | $\begin{array}{r} 245 \\ 131 \\ \hline \end{array}$ | $\begin{array}{r} 289 \\ 154 \\ \hline \end{array}$ | 321 173 | $\begin{gathered} 350 \\ 198 \\ \hline \end{gathered}$ | 263 151 | 311 177 | $\begin{aligned} & 338 \\ & 200 \\ & \hline \end{aligned}$ | $\begin{array}{r} 363 \\ 229 \\ \hline \end{array}$ |
| 49 |  |  |  |  |  |  | 218 106 | $\begin{array}{r} 257 \\ 124 \\ \hline \end{array}$ | 289 139 | $\begin{array}{r} \hline 334 \\ 159 \\ \hline \end{array}$ | $\begin{array}{r} 235 \\ 124 \\ \hline \end{array}$ | 278 144 | 312 163 | $\begin{aligned} & \hline 343 \\ & 186 \\ & \hline \end{aligned}$ | $\begin{aligned} & 252 \\ & 142 \\ & \hline \end{aligned}$ | 298 167 | $\begin{aligned} & 331 \\ & 188 \\ & \hline \end{aligned}$ | 355 215 |
| 50 |  |  |  |  |  |  | $\begin{gathered} 209 \\ 100 \end{gathered}$ | 247 117 | 277 131 | $\begin{aligned} & 321 \\ & 150 \end{aligned}$ | $\begin{gathered} 226 \\ 116 \\ \hline \end{gathered}$ | $\begin{aligned} & 267 \\ & 136 \\ & \hline \end{aligned}$ | $\begin{aligned} & 300 \\ & 153 \\ & \hline \end{aligned}$ | $\begin{aligned} & 336 \\ & 175 \\ & \hline \end{aligned}$ | $\begin{array}{r} 242 \\ 134 \end{array}$ | $\begin{array}{r} 287 \\ 157 \\ \hline \end{array}$ | $\begin{aligned} & 322 \\ & 177 \\ & \hline \end{aligned}$ | $\begin{array}{r} 348 \\ 202 \\ \hline \end{array}$ |
| - 51 |  |  |  |  |  |  | $\begin{array}{r} 201 \\ 94 \\ \hline \end{array}$ | $\begin{array}{r} 237 \\ 110 \\ \hline \end{array}$ | 267 124 | 308 141 | $\begin{gathered} 217 \\ 110 \\ \hline \end{gathered}$ | $\begin{aligned} & 256 \\ & 128 \\ & \hline \end{aligned}$ | $\begin{aligned} & 288 \\ & 144 \\ & \hline \end{aligned}$ | $\begin{aligned} & 329 \\ & 165 \\ & \hline \end{aligned}$ | $\begin{aligned} & 233 \\ & 126 \\ & \hline \end{aligned}$ | $\begin{gathered} 276 \\ 148 \\ \hline \end{gathered}$ | $\begin{array}{r} 309 \\ 166 \\ \hline \end{array}$ | 341 191 |
| 52 |  |  |  |  |  |  | $\begin{array}{r} 193 \\ 88 \\ \hline \end{array}$ | $\begin{aligned} & 228 \\ & 104 \\ & \hline \end{aligned}$ | $\begin{aligned} & 256 \\ & 117 \\ & \hline \end{aligned}$ | $\begin{aligned} & 297 \\ & 133 \end{aligned}$ | $\begin{array}{r} 209 \\ 103 \\ \hline \end{array}$ | $\begin{array}{r} 247 \\ 121 \\ \hline \end{array}$ | $\begin{array}{r} 277 \\ 136 \\ \hline \end{array}$ | $\begin{aligned} & \hline 321 \\ & 156 \\ & \hline \end{aligned}$ | $\begin{array}{r} 224 \\ 119 \\ \hline \end{array}$ | $\begin{array}{r} 265 \\ 139 \\ \hline \end{array}$ | 298 157 | 335 180 |
| 53 |  |  |  |  |  |  |  |  |  |  | 201 98 | 237 114 | $\begin{array}{r} 267 \\ 128 \\ \hline \end{array}$ | 309 147 | 216 112 | 255 132 | 286 148 | 328 170 |
| 54 |  |  |  |  |  |  |  |  |  |  | $\begin{array}{r} 193 \\ 92 \\ \hline \end{array}$ | $\begin{gathered} 229 \\ 108 \\ \hline \end{gathered}$ | $\begin{array}{r} 257 \\ 121 \end{array}$ | $\begin{array}{r} 297 \\ 139 \\ \hline \end{array}$ | $\begin{gathered} 208 \\ 106 \\ \hline \end{gathered}$ | 246 125 | 276 140 | 319 161 |
| 55 |  |  |  |  |  |  |  |  |  |  | 186 87 | 220 | 248 115 | $\begin{array}{r} 287 \\ 132 \\ \hline \end{array}$ | 200 101 | 237 118 | 266 133 | 308 152 |
| 56 |  |  |  |  |  |  |  |  |  |  | $\begin{array}{r} 180 \\ 83 \end{array}$ | $\begin{array}{r} 213 \\ 97 \\ \hline \end{array}$ | $\begin{gathered} 239 \\ 109 \\ \hline \end{gathered}$ | $\begin{array}{r} 276 \\ 125 \\ \hline \end{array}$ | $\begin{array}{r} 193 \\ 95 \\ \hline \end{array}$ | $\begin{gathered} 229 \\ 112 \\ \hline \end{gathered}$ | $\begin{array}{r} 257 \\ 126 \\ \hline \end{array}$ | 297 144 |
| 57 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 187 90 | $\begin{gathered} 221 \\ 106 \\ \hline \end{gathered}$ | $\begin{aligned} & 248 \\ & 119 \\ & \hline \end{aligned}$ | 287 137 |
| 58 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 180 86 | 213 101 | 239 113 | 277 130 |
| 59 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 174 81 | $\begin{array}{r} 206 \\ 95 \\ \hline \end{array}$ | 231 108 | 268 123 |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 168 | 199 91 | 224 102 | 259 117 |

*Indicates Nominal Depth of steel joists only.
$\dagger$ Approximate Weights per Linear Foot of steel joists only. Accessories and nailer strip not included.
*†See manufacturers' catalog for detailed information on specific joist types.
**Section 5.9 of the "Standard Specifications for Open Web Steel Joists, J-and H-Series" limits the design LIVE load deflection as follows:
FLOORS, $1 / 360$ span. ROOFS, $1 / 360$ of span where a plaster ceiling is attached or suspended; $1 / 240$ of span for all other cases.

LT-49

DC ENGINEERING

## SOLAR PANEL AND MOUNTING INFORMATION

U-BUILDER PROJECT REPORT
VERSION: 3.1.6

| Project title | Project id |
| :--- | :--- |
| ROOFMOUNT RM10 created |  |
| EF551222 |  |$\quad$ Sept. 28, 2021, 1:46 p.m.


| NAME | Fire 2 Draft | Designed by wmcmahon@cityofmadison.com |
| :---: | :---: | :---: |
| ADDRESS |  | ROOFMOUNT RM10 |
|  |  | Hanwha/Q-Cells |
| CITY, STATE | Madison, WI | 38 - Q-PEAK DUO L-G5.2 380 |
| MODULE | Hanwha/Q-Cells Q-PEAK DUO L-G5.2 380 | $824.50 \mathrm{ft}^{2}$ |

BILL OF MATERIALS LEGEN: $\|$ Base System Part ■accessory

| PART <br> NUMBER | PART TYPE | DESCRIPTION | QUANTITY | SUGGESTED <br> QUANTITY | UNIT PRICE <br> (USD) |
| :--- | :--- | :--- | :--- | :--- | :--- |
| UserSuppliedBallast Block | Ballast Block | TOTAL LIST PRICE |  |  |  |
| (USD) |  |  |  |  |  |


| BASE SYSTEM PRICE | \$2968.77 | ACCESSORIES PRICE | \$263.14 | TOTAL PRICE |
| ---: | ---: | ---: | ---: | ---: |

This design is to be evaluated to the product appropriate Unirac Code Compliant Installation Manual which references International Building Code 2009, 2012, 2015, 2018 and ASCE 7-05, ASCE 7-10, ASCE 7-16 and California Building Code 2010, 2016. The installation of products related to this design is subject to requirements in the above mentioned installation manual.

[^0]Standard $4 \times 8 \times 16$ inch cap blocks. Nationwide availability. Please confirm the weight of your ballast block as this will affect the total blocks required for your installation.

Ballast Bay 310710 RM Ballast Bay 10 Degree
Aluminum ballast bay attaches to north and south module edges (for 10 degree tilt installations) and provides ballast placement location.

RM Roof Pad 310760 RM Roof Pad 118
TPE 201-73 BK Santoprene Roof Pad. PLEASE NOTE: Depending on your roof type and seismic conditions, some quantity of roof pads may be required. These will be listed separately on your bill of materials.
Module Clip 310750 RM Module Clip
Aluminum clip fastens module frame to ballast bay and provides bonding path from module
to bay to module.

RM Hex Bolt 310751 RM Hex Bolt (Module Clip)
Hex bolt with integrated locking patch.

Plan review

| AVERAGE PSF | 3.84 psf |
| :--- | ---: |
| TOTAL NUMBER OF MODULES |  |
| TOTAL KW | 38 |
| TOTAL MODULE AREA | 14.44 KW |
| TOTAL WEIGHT ON ROOF | $\sim 1349 \mathrm{ft}^{2}$ |
| RACKING WEIGHT | 5180 lbs |
| MODULE WEIGHT | 207 lbs |
| BALLAST WEIGHT | 1968 lbs |
| MAX BAY LOAD (DEAD) | 2888 lbs |

## Loads Used for Design

| BUILDING CODE | ASCE 7-10 |
| :--- | ---: |
| BASIC WIND SPEED | 115.00 mph |
| GROUND SNOW LOAD | 30.00 psf |
| SEISMIC (SS) | 0.08 |
| ELEVATION | 871.00 ft |
| WIND EXPOSURE |  |
| MRI | B |

RISK CATEGORY II
VELOCITY PRESSURE, QZ 15.4 psf

| Loads Determined by Zip | 53713 |
| :--- | ---: |
| cIty, state | Madison, WI |
| basic wind speed | 115.00 mph |
| GROUND SNOW LOAD | 30.00 psf |


| PRODUCT | ROOFMOUNT RM10 |
| :---: | :---: |
| MODULE MANUFACTURER | Hanwha/Q-Cells |
| MODEL | Q-PEAK DUO L-G5.2 380 |
| MODULE WATTS | 380 watts |
| MODULE LENGTH | 79.30" |
| MODULE WIDTH | 39.40" |
| MODULE THICKNESS | $1.38{ }^{\prime \prime}$ |
| MODULE WEIGHT | 51.80 lbs |
| BALLAST BLOCK (CMU) WEIGHT | 38.5 lbs |
| MAX BLOCKS PER BAY | 4 |
| BUILDING HEIGHT | 20.00 ft |
| ROOF TYPE | MINERAL_CAP |
| PARAPET HEIGHT | <= 1/2 Array Height (<= 6 inches) |

Roof Area 1 - Array 1

| AVERAGE PSF | 3.91 psf | minimum seismic separation (UNATTACHED ARRAYS) * |  |
| :---: | :---: | :---: | :---: |
|  |  | ARRAY TO ARRAY: | 3.0" |
| TOTAL NUMBER OF MODULES: | 18 | TO FIXED OBJECT ON ROOF: | 6.0" |
| TOTAL KW: | 6.84 KW | TO ROOF EDGE WITH QUALIFYING PARAPET: | 6.0" |
| TOTAL AREA: | $642 \mathrm{ft}^{2}$ | TO ROOF EDGE WITHOUT QUALIFYING PARAPET: | 9.0" |
| TOTAL WEIGHT ON ROOF: | 2511 lbs | MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) |  |
| RACKING WEIGHT: | 98 lbs | MAX NUMBER OF NORTH-SOUTH ROWS: | 26 |
| MODULE WEIGHT: | 932 lbs | MAX NUMBER OF EAST-WEST COLUMNS: | 115 |
| BALLAST WEIGHT: | 1425 lbs | *In jurisdictions that follow SEAOC PV-1 m |  |

## Roof Area 1 - Array 2

| AVERAGE PSF | 3.78 psf |
| :--- | ---: |
| TOTAL NUMBER OF MODULES: |  |
| TOTAL KW: | 20 |
| TOTAL AREA: | 7.60 KW |
| TOTAL WEIGHT ON ROOF: | $707 \mathrm{ft}^{2}$ |
| RACKING WEIGHT: | 2670 lbs |
| MODULE WEIGHT: | 109 lbs |
| BALLAST WEIGHT: | 1036 lbs |
| ATTACHMENT COUNT | 1463 lbs |


| MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) * |  |
| :--- | ---: |
| ARRAY TO ARRAY: | $3.0^{\prime \prime}$ |
| TO FIXED OBJECT ON ROOF: | $6.0^{\prime \prime}$ |
| TO ROOF EDGE WITH QUALIFYING PARAPET: | $6.0^{\prime \prime}$ |
| TO ROOF EDGE WITHOUT QUALIFYING PARAPET: | $9.0^{\prime \prime}$ |
| MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) * |  |
| MAX NUMBER OF NORTH-SOUTH ROWS: | 26 |
| MAX NUMBER OF EAST-WEST COLUMNS: | 115 |
| *In jurisdictions that follow SEAOC PV-1 methodology. |  |

## RM10 - Ballasted Flat Roof Systems

Limitations of Responsibility: It is the user's responsibility to ensure that inputs are correct for your specific project.
Unirac is not the solar, electrical, or building engineer of record and is not responsible for the solar, electrical, or building design for this project.

## Building Assumptions

1. Risk Category III
2. Building Height $\leq 50 \mathrm{ft}$
3. Building Height > 50 ft : only where (longest length of building $x$ building height)^ $0.5 \leq 100 \mathrm{ft}$
4. Roof Slope $\geq 0^{\circ}(0: 12)$ and $\leq 3^{\circ}(5 / 8: 12)$ for Seismic Design Category C, D, E and F. For low seismic regions Seismic Design Category $A$ and $B$ (provided Array Importance factor $=1.0$ ), Roof Slope $\geq 0^{\circ}(0: 12)$ and $\leq 7^{\circ}(11 / 2: 12)$.
5. Roofing Material Types: EDPM, PVC, TPO, or Mineral Cap
6. Surrounding Building Grade: Level

## Ballast Blocks

The installer is responsible for procuring the ballast blocks (Concrete Masonry Units - CMU) and verifying the required minimum weight needed for this design. CMU should comply with ASM standard specification for concrete roof pavers designation (C1491 or C90 with an integral water repellant suitable for the climate it is placed. It is recommended that the blocks are inspected periodically for any signs of degradation. If degradation of the block is observed, the block should immediately be replaced.
The CMU ballast block should have nominal dimensions of 4 " $\times 8$ "" $\times 16^{\prime \prime}$. The actual block dimensions are $3 / 8^{\prime \prime}$ less than the nominal dimensions. Ballast blocks should have a weight as specified for the project in the "Inspection" section of this report.

## Design Parameters

1. Risk Category I to III
2. Wind Design
a. Basic Wind Speed: 85-120 mph (ASCE 7-05)/110-150 mph (ASCE 7-10)/90-180 mph (ASCE 7-16)
b. Exposure: B, C or D (ASCE 7-05/ASCE 7-10)
c. 25 year Design Life/50 year Design Life for ASCE 7-16
d. Elevation: Insertion of the project at - grade elevation can result in a reduction of wind pressure. If your project is in a special case study region or in an area where wind studies have been performed, please verify with your jurisdiction to ensure that elevation effects have not already been factored into the wind speed. If elevation effects have been included in your wind speed, please select 0 ft as the project site elevation.
e. Wind Tunnel Testing: Wind tunnel testing coefficients have been utilized for design of the system.
3. Snow Design
a. Ground Snow Load: 0-80 psf (ASCE 7-10/ASCE 7-16)
b. Exposure Factor: 0.9
c. Thermal Factor: 1.2
d. Roof Snow Load: Calculation per Section 7.3 (ASCE 7-05/ASCE 7-10/ASCE 7-16)
e. Unbalanced/Drifting/Sliding: Results are based on the uniform snow loading and do not consider unbalanced, drifting, and sliding conditions
4. Seismic Design
a. Report SEAOC PV1-2012/ASCE 7-16 SECTION 13.6.12 - Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays
b. Seismic Site Class: A, B, C, or D (ASCE 7-05/ASCE 7-10/ASCE 7-16)
c. Importance Factor Array (Ip): 1.0
d. Importance Factor Building (le): 1.0
e. Site Class: D

## Properties

1. Bay Weight: $\sim 3.5 \mathrm{lbs}$
2. Module Gaps $(E / W)=0.25$ in
3. Bays: North row bays overhang the module by $\sim 19.5$ inches.

## Module Properties

1. Module return flange: Minimum of 0.9 in (when using 1-3/4 in. clip bolts) is required.
2. Module return flange: Minimum of 0.65 in (when using 2 in . clip bolts) is required.

## Testing

1. Coefficient of Friction
2. Wind Tunnel
3. UL 2703
4. Component Testing (Bay and Clamp)

## Setbacks

For the wind tunnel recommendations in U-Builder to apply, the following setbacks should be observed/followed for U-Builder wind design:

1. Modules should be placed a minimum of 3 feet from the edge of the building in any direction.
2. If the array is located near an obstruction that is 3.5 feet wide and 3.5 feet high or larger, the nearest
module of the array must be located a distance from the obstruction that is greater than or equal to the height of the obstruction. Exception: When using ASCE 7-16 Building Code and using the obstruction feature in the module editor to accurately model the size and location of obstruction.
3. Installations within the setbacks listed above require site specific engineering ${ }^{2}$
4. The setbacks above are for wind. High seismic areas, fire access isles, mechanical equipment, etc., may require larger setbacks than listed above for wind.

## Site Specific Engineering

Conditions listed below are beyond the current capabilities of $U$-Builder. Site specific engineering is required.

1. Wind designs for a project design life exceeding 25 years ${ }^{\text {1/ASCE 7-16 }}$
2. Building assumptions and design parameters outside of $U$-Builder assumptions ${ }^{2}$
3. Attachments ${ }^{2}$
4. Risk Category III or IV projects (U-Builder can be adjusted for the correct wind, but not the seismic or snow design) ${ }^{2}$
5. Wind tunnel testing reduction factors are not permitted by the Authority Having Jurisdiction (AHJ) ${ }^{3}$
6. Seismic designs that fall outside SEAOC PV1-2012/ASCE 7-16 SECTION 13.6 .12 recommendations ( $>3 \%$ roof slope, or AHJ's that require shake table testing or non-linear site-specific response history analysis) ${ }^{3}$
7. Signed and sealed site-specific calculations, layouts, and drawings ${ }^{3}$

## Notes:

${ }^{1}$ Please contact info@unirac.com.
2 Please contact EngineeringServices@unirac.com for more information.
${ }^{3}$ Please contact Theresa Allen with PZSE Structural Engineers at theresa@pzse.com. These items will require direct coordination with PZSE to complete the requested services.

## Roof Area 1 / Roof Area 1 - Array 1



LEGEND

Module

Standard corner bay with CMU block count

4 Supplemental bay with CMU block count

## NOTE

Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6 . The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Install roof pads to every bay.

## Layout Dimensions

| NS DIMENSION | $\sim 16.20 \mathrm{ft}$ |
| :--- | :---: |
| EW DIMENSION | $\sim 39.78 \mathrm{ft}$ |


| ROW | MODULES | BAYS | BALLAST BLOCKS (CMU) | BALLAST WEIGHT (LBS) |
| :--- | :--- | :--- | :--- | :--- |
| 1 | 6 | 7 | 12 | 462 |
| 2 | 6 | 7 | 9 | 347 |
| 3 | 6 | 7 | 9 | 347 |
| 4 | 0 | 7 | 7 | 270 |



LEGEND

ModuleStandard corner bay with CMU block count
4
Supplemental bay with CMU block count

## note

Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6 . The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Install roof pads to every bay.

## Layout Dimensions

| NS DIMENSION | $\sim 21.06 \mathrm{ft}$ |
| :--- | :--- |
| EW DIMENSION | $\sim 39.78 \mathrm{ft}$ |


| ROW | MODULES | BAYS | BALLAST BLOCKS (CMU) | BALLAST WEIGHT (LBS) |
| :--- | :--- | :--- | :--- | :--- |
| 1 | 4 | 5 | 8 | 308 |
| 2 | 4 | 5 | 5 | 193 |
| 3 | 6 | 7 | 9 | 347 |
| 4 | 6 | 7 | 9 | 347 |
| 5 | 0 | 7 | 7 | 270 |


[^0]:    Ballast Block UserSupplied Ballast Block

